

Literature Review using multi-Agent system

Aman Sudhakar Bhanse (Matrikelnummer: 430874)

RPTU Kaiserslautern, Department of Computer Science

Note: This report contains a project documentation and reflection on the portfolio task submitted for the lecture Engineering with Generative AI in WiSe 2024-25. This report is an original work and will be scrutinised for plagiarism and potential LLM use.

1 Portfolio documentation

1.1 Introduction

This project is centered on designing a multi-agent system capable of producing a literature review of at least 500 words based on a specific topic and a provided set of research papers. The system integrates a Multi-agent approach. It will perform tasks such as fetching the papers from google scholar, summerise the papers, extracting key information aligned with the given topic, and use this information to create cohesive literature review. The goal is to create an efficient and reliable tool for generating high-quality academic content while maintaining originality and accuracy.

1.2 Research Phase

- During the research phase, we carefully identified and selected key components essential to the project, including a Large Language Model (LLM) and an Evaluation Metric. These choices were made based on their ability to effectively meet the specific requirements of the task.
- Significant time was also dedicated to designing the solution architecture, which involved defining the roles and responsibilities of each agent, as well as establishing communication protocols and data flow between the agents.
- Additionally, the research phase involved exploring various methods for retrieving and summarizing academic papers. A key challenge identified was that directly downloading papers and using OCR for text extraction could lead to excessive token consumption, making the process inefficient for the model. To address this, an API-based approach was finalized for fetching papers from Google Scholar. This approach eliminates the overhead of downloading and extracting text while also reducing token usage, as only relevant sections of the paper are extracted and provided to the multi-agent system.

1.2.1 LLMs

- **Model Selected:** llama3.3 (via Groq Interference)
- **Justification:**

- **Open Source:** Open-Source Advantage: If Llama 3 is open-source, it provides flexibility, transparency, and cost-effectiveness, allowing you to modify and adapt the model without relying on proprietary systems.
- **Community Support:** Llama 3 has a large community of developers and researchers who can provide support, updates, and additional resources, ensuring the model's reliability and scalability.
- **State-of-the-Art Performance:** By outperforming its predecessor, Llama 2, in a number of areas, including reasoning, instruction following, question answering, and code production, Llama 3 sets a new standard at the 70B parameter scale.
- **Long Context Length:** Llama 3 have big context length which is useful for summarization tasks.

1.2.2 Evaluation Metric Selection

- **Metric Selected:** The selected evaluation metric for this project is the **ROUGE Score**.
- **Justification:**
 - **Industry Standard for Text Evaluation:** ROUGE (Recall-Oriented Understudy for Evaluation) is widely used to assess AI-generated text, particularly in tasks like translation and summarization.
 - **Measures Content Overlap:** It systematically compares AI-generated literature reviews with human-written references, analyzing content similarity at various levels of granularity.
 - **Ensures Recall and Precision:** ROUGE evaluates both recall (how much relevant information is retained) and precision (how accurately key insights are captured), ensuring a comprehensive assessment of text quality.

1.2.3 Design Phase

- The system architecture consist of two primary agents: the Writer Agent and the Editor Agent. The Writer Agent is responsible for generating the initial draft of the literature review, while the Editor Agent gives feedback to writer agent and refines the content.
- There are 4 teams in the system:
 - **Summarization Team :** Responsible for summarizing the research papers fetched from Google Scholar.
 - **Filter Team :** Filter out the irrelevant papers which are not aligned with the given topic.
 - **Literature Creation Team :** Responsible for creating the literature review based on topic given by user and filtered summaried papers.
 - **Draft Revising Team :** Human in loop, if the generated literature review is not up to the mark, the human reviewer will provide feedback and intervene to improve the quality.

- **Workflow:**
 - User gives input topic and research papers title to the summarization team.
 - Summarization team fetches the research papers from Google Scholar and summarize each paper in 100 words and this input is passed to the filter team.
 - Filter Team, Filter out the irrelevant papers which are not aligned with the given topic. The filtered summarized papers are then passed to the Literature Creation Team. Filtration of relevant information happens here in this team.
 - Literature Creation Team, creates the literature review based on the topic given by user and the filtered summarized papers. The generated literature review is then passed to the Draft Revising Team.
 - Draft Revising Team, if the user is not satisfied with the generated literature review, the human reviewer will provide feedback and intervene to improve the quality and revising team will revise the literature review.
 - if the user is satisfied with the generated literature review, the literature review is returned to the user.

1.2.4 Implementation Phase

- **Connecting to LLM:** We used `OpenAIChatCompletionClient` to connect to the Llama model, enabling efficient interaction and text generation capabilities.
- **Integrating Tools:** We utilized the `scholarly` Python library to efficiently fetch research papers from Google Scholar and extract relevant information. Additionally, the `autogen` library was employed to design and implement the multi-agent system, ensuring seamless collaboration and task execution among agents.
- **Building Agents:** The system comprises two primary agents:
 - **Writer Agent:** Responsible for drafting the literature review by synthesizing information from the research papers.
 - **Editor Agent:** Provides feedback on the draft, refines the content, and ensures coherence and quality.
- **Human-in-the-Loop:** A human reviewer is incorporated into the workflow to provide feedback and intervene when the output does not meet the desired quality standards, ensuring the final product is both accurate and high-quality.
- **Implementing Communication:** The `autogen` library was utilized to establish robust communication channels between agents, ensuring seamless data exchange and efficient task coordination. Different teams were assigned specific tasks, with communication parameters tailored to their roles. For instance, the drafting team, comprising the Writer Agent and Editor Agent, collaborates closely to produce and refine the literature review. To optimize their interaction, a maximum message limit of 8 was set for this team, facilitating focused and efficient communication. The drafting team is responsible for both creating and revising the literature review, ensuring high-quality output through iterative collaboration.

- **System testing:** For testing the system, user is providing the topic and the research papers. The system is then generating the literature review based on the given topic and research papers. The generated literature review is then evaluated using the ROUGE score to assess its quality and accuracy. The system is tested with different topics and research papers to ensure its robustness and reliability.
- **Evaluating Output :** The generated literature review is evaluated using the ROUGE score to assess its quality and accuracy. The ROUGE score provides a quantitative measure of the similarity between the generated text and the reference text, helping to validate the system's performance.

2 Reflection

1. What was the most interesting thing you learned while working on the portfolio? What aspects did you find interesting or surprising? **Answer:** Working with multi-agent systems has always been an exciting experience for me. I thoroughly enjoyed exploring the various types of agents and understanding how they interact to solve complex problems. The most fascinating aspect I learned while working on the portfolio was how multi-agent systems can effectively model and simulate real-world scenarios. It was intriguing to observe how agents adapt to their environment, respond to changing conditions, and collaborate to achieve shared objectives. Additionally, I found it captivating to delve into different agent architectures and their ability to model diverse behaviors. For instance, understanding how reactive agents differ from deliberative agents and how hybrid architectures combine the strengths of both was particularly enlightening. The versatility of multi-agent systems truly surprised me, as they can be applied across a wide range of domains, including robotics, artificial intelligence, economics, and social sciences. Overall, the portfolio work deepened my appreciation for the potential of multi-agent systems. It highlighted their ability to address complex, dynamic problems and their relevance in advancing technology and research. This experience has inspired me to further explore the field, particularly in areas like agent communication and coordination, which are critical for building more robust and efficient systems.
2. Which part of the portfolio are you (most) proud of? Why? What were the challenges you faced, and how did you overcome them? **Answer:** The most challenging part was to pass the message between different agent team. Sometimes the model was not outputting the answers in given template. But we better prompts and the model was able to generate the answers in the given template. The most proud part of the portfolio was the final implementation of the multi-agent system. It was really satisfying to see the agents interacting with each other and collaborating to achieve common goals. I was proud of the way I was able to design and implement the agent architectures and integrate the agents into a coherent system. The challenges I faced were mainly related to debugging and testing the system. I overcame these challenges by breaking down the problem into smaller sub-problems, testing each component individually, and gradually integrating them into the larger system. I also used debugging techniques to identify and fix errors in the code.

Overall, I was proud of the way I was able to overcome these challenges and deliver a working multi-agent system.

3. What adjustments to your design and implementation were necessary during the implementation phase? What would you change or do differently if you had to do the portfolio task a second time? What would be potential areas for future improvement? **Answer:** During the implementation phase, I had to simplify the agent architecture due to time constraints, focusing on a smaller, more manageable design. Adjustments were made to the communication mechanisms between agents to ensure seamless interaction. If I were to redo the portfolio task, I would dedicate more time to the design phase and aim to implement a more sophisticated multi-agent architecture. Additionally, I would explore advanced AI techniques to enhance agent communication and coordination. For future improvements, there is significant potential to extend the multi-agent system to model more realistic scenarios. Incorporating advanced communication protocols and exploring decentralized decision-making could make the system more robust and efficient. Researching innovative ways for agents to communicate and collaborate would also be a priority. Overall, the experience highlighted the importance of iterative design and the need for flexibility during implementation. It also underscored the potential of multi-agent systems in solving complex problems and inspired me to delve deeper into this field. By addressing these areas, I believe the system could be significantly improved, paving the way for more advanced applications in research and real-world scenarios.
4. Include a brief section on ethical considerations when using these models in the research domain. **Answer:** Ethical considerations are incredibly important when using Generative AI models in research. One of the biggest challenges is the risk of misinformation—these models can sometimes produce inaccurate or misleading content. That’s why it’s crucial for researchers to double-check the outputs and verify the facts. Another major concern is data privacy and security, especially when dealing with sensitive or confidential information. It’s essential to follow data protection regulations to avoid any breaches. Lastly, plagiarism is something to keep in mind. Researchers need to ensure that the content generated by AI is original and doesn’t inadvertently copy existing work. Balancing these ethical aspects is key to using AI responsibly in research.
5. From the lecture/course including guest lectures, what topic excited you the most? Why? What would you like to learn more about and why? **Answer:** I really enjoyed the assignments and exercises that focused on building AI-powered applications. It was exciting to see how AI models can be integrated into real-world systems and used to solve practical problems. I was particularly interested in the guest lecture on "The Evolution of Scaling Laws in Large Language Models" because it provided a fascinating insight into the development of large language models and their impact on AI research. I would like to learn more about the latest advancements in AI research, especially in the field of Generative AI. I am interested in exploring new models and techniques that push the boundaries of what’s possible with AI. I would also like to learn more about the ethical implications of AI and how we can ensure that these technologies are used responsibly. There was also a guest lecture on AWS, which was really interesting. I would like to learn more about how

to deploy AI models on the cloud and scale them to handle large datasets and high traffic. This would be valuable for building robust and scalable AI applications.

6. How did you find working with DIFY platform during the course work? Would you recommend using DIFY in learning Generative AI technologies and why? What is the best start for learning Generative AI either by Python code or No-code platforms and why? **Answer:** I find DIFY good for quick prototyping. It has good interaction of models providers and the best part of it is that it is open source. I would recommend using DIFY for learning Generative AI technologies because it provides a user-friendly interface and a wide range of pre-trained models that can be easily integrated into your projects. It's a great way to get started with Generative AI without having to worry about the technical details. However, I think it's also important to learn how to code in Python and work with Generative AI libraries like TensorFlow and PyTorch. This gives you more flexibility and control over the models and allows you to customize them to your specific needs. I would recommend starting with a No-code platform like DIFY to get a feel for how Generative AI works and then gradually transition to Python coding to deepen your understanding and skills.
7. How did you find the assignments and exercise in the course and how they help you in portfolio exam? **Answer:** The assignments and exercises were instrumental in preparing for the portfolio exam. They provided a solid foundation by allowing me to practice and apply the concepts learned during the lectures. These tasks offered an opportunity to experiment with various models and techniques, helping me to better understand the material. The feedback from instructors was invaluable in identifying my strengths and areas for improvement. This iterative process of learning and refining my skills boosted my confidence in tackling the portfolio exam. The assignments also simulated real-world scenarios, enabling me to apply theoretical knowledge in a practical context. Overall, they were an essential part of the learning process and significantly contributed to my readiness for the portfolio exam

All of the resources used by the student to complete the portfolio task should be organised in the references section. **Note that the Reference section does not count towards the number of pages of the report.** Example references are given below [1] [2] [3]. **If you are using a reference manager like Zotero, you can export your Zotero library as a .bib file and use it on Overleaf. As you cite the article/technology/library in your main text, the References section will automatically update accordingly.** Please include a full list of references found. If students are using Zotero for their research paper management, a bibTeX will help them during citation which automatically adds references to the report.

References

- [1] Albert Einstein. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921, 1905.
- [2] Donald Knuth. Knuth: Computers and typesetting.
- [3] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The L^AT_EX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.